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MULTI-LAYER READING DEVICE

REFERENCE TO EARLIER FILED PROVISIONAL APPLICATIONS

This patent application claims the benefit of priority from, and incorporates by reference the entire disclosure of, co-pending U.S. Provisional Patent Application Serial Nos. 60/182,742, filed on February 16, 2000, 60/190,343, filed on March 16, 2000, and 60/192,662, filed on March 28, 2000.

CROSS REFERENCE TO RELATED APPLICATION

~~The present~~ application for patent ~~is related to and hereby incorporates by reference the~~ subject matter

disclosed in U.S. Patent Application Serial Nos. _____ (Attorney Docket No.34650-566PT), entitled "Specially Formatted Paper Based Applications of a Mobile Phone"; _____ (Attorney Docket No.34650-569PT), entitled "Method and System for Using an Electronic Reading Device as a General Application Input and Navigation Interface"; _____ (Attorney Docket No.34650-578PT), entitled "Predefined Electronic Pen Applications in Specially Formatted Paper"; _____ (Attorney Docket No. 34650-579PT), entitled "A System and Method for Operating an Electronic Reading Device User Interface"; _____ (Attorney Docket No. 34650-601PT), entitled "Method and System for Using an Electronic Reading Device on Non-paper Devices"; _____ (Attorney Docket No. 34650-604PT), entitled, "Method and System for Configuring and Unlocking an Electronic Reading Device"; _____ (Attorney Docket No. 34650-606PT), entitled "Printer Pen"; _____ (Attorney Docket No. 34650-607PT), entitled "Method and System for Electronically Recording Transactions and Performing Security Function"; _____ (Attorney Docket No. 34650-608PT), entitled "Electronic Pen with Ink On/ink off Function and

Paper Touch Sensing"; _____ (Attorney Docket No. 34650-654PT), entitled "Method and System for Handling FIFO and Position Data in Connection with an Electronic Reading Device"; _____ (Attorney Docket No. 34650-655PT), entitled "Hyperlink Applications for an Electronic Reading Device"; _____ (Attorney Docket No. 34650-656PT), entitled "Measuring Applications for an Electronic Reading Device"; _____ (Attorney Docket No. 34650-657PT), entitled "Method and System for Controlling an Electronic Utility Device Using an Electronic Reading Device"; and _____ (Attorney Docket No. 34650-658PT), entitled "Positioning Applications for an Electronic Reading Device"; and _____ (Attorney Docket No.34650-673PT), entitled "Method for Sharing Information Between Electronic Reading Devices"; and in U.S. Provisional Patent Application Serial Nos. _____ (Attorney Docket No.34650-671PL), entitled "Electronic Pen for E-Commerce Implementations"; and _____ (Attorney Docket No.34650-672PL), entitled "Electronic Pen Help Feedback and Information Retrieval"; all filed concurrently herewith.

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates in general to the communications field, and in particular to an interaction of an electronic reading device with an address pattern.

Description of Related Art

Numerous devices exist for accepting user input and controlling user interaction with desktop and portable computers, personal digital assistance (PDAs), mobile phones, and other types of electronic devices. For example, a keyboard can be used to accept typed input and other types of commands, a mouse or a track-ball can be used to provide relative motion input as well as various types of point-and-click selections, a keypad can be used to provide input of numerical data and functional commands, navigational keys can be used for scrolling lists or otherwise repositioning a cursor, and various types of touchpads or touchscreens can be used to provide absolute positional coordinate inputs. Each type of mechanism for accepting input and for supporting user interaction has benefits and disadvantages in terms of size, convenience, flexibility, responsiveness, and easy

of use. Generally, the selection of a particular type of input mechanism is dependent upon the function of the application and the degree and type of interaction required.

With the ever expanding capabilities and availability of applications both on the Internet and the area of wireless technology, there continues to be a need to develop and provide new mechanisms for accepting input and interacting with users. In particular, some of the existing technologies suffer from drawbacks or limitations, such as size and flexibility, that make them impractical and/or inconvenient to use in some situations. By expanding the range of mechanisms for supporting user interaction, application developers and end-users can have greater flexibility in the selection of input devices. Preferably, any such new mechanisms will provide increased flexibility and will maximize user convenience. In addition, the development of new mechanisms for interacting with users can expand the realm of potential applications.

For example, while a keyboard typically provides a great deal of flexibility, particularly when it is used in connection with a mouse, a touchscreen, or other

navigational device, its size makes it inconvenient in many cases, especially in the wireless context.

Mechanisms also exist for inputting or scanning text, images, or other information printed on a sheet of paper and storing the scanned information in an electronic device. Desktop scanners, for example, perform such a function, but are relatively large and are not portable. Although hand scanners also exist, they have to be moved over the printed information in a clearly specified way (e.g., normally in one uninterrupted straight line movement). In addition, each scan performed with the hand scanner is independent from any previous or subsequent scans, making it difficult or impossible to assemble several scans into a complete image. Thus, a hand scanner can be inconvenient and difficult to use.

SUMMARY OF THE INVENTION

The present invention comprises a method and system for scanning information printed on a surface using an electronic reading device, such as a hand scanner. The surface can comprise, for example, a sheet of paper or a display screen. The surface includes both printed information, such as an image or text, and an address

pattern, such as a pattern of dots. The address pattern is formatted such that a position of the electronic reading device relative to the address pattern can be determined by examining only a small portion of the address pattern at and around the particular position.

By scanning the electronic reading device across the surface, portions of the printed information can be detected using a reading sensor on the electronic reading device. At approximately the same time as each detection of a portion of the printed information is performed, an associated portion of the address pattern is also detected. A processor can subsequently reconstruct an electronic copy of the printed information by positioning the detected portions of the printed information according to their associated portions of the address pattern.

Preferably, the printed information and the address pattern are printed or otherwise depicted using two different colors within one or more of the visible light spectrum, the ultraviolet spectrum, and the infrared spectrum. By performing the detection in a way that allows the reading sensor to distinguish between the different colors, the electronic reading device can also

distinguish the printed information from the address pattern.

In one embodiment of the invention, the reading device includes a plurality of sensors. At least one of the sensors includes a filter for filtering out parts of the light spectrum reflected by either a layer that includes the printed information or a layer that includes the address pattern. Accordingly, sensors that include the filter are used to detect one of the layers while sensors that do not include the filter are used to detect the other of the layers. To facilitate this detection, the electronic reading device can also include a light emitter for illuminating the surface with a broad spectrum light.

In another embodiment, the electronic reading device includes two light emitting diodes (LEDs), one of which emits infrared light and the other of which emits non-infrared light. By alternately activating the LEDs, the reading sensor can alternately detect the printed information and the address pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, reference is made to the following detailed description taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a block diagram of a system in which an electronic pen can be used as an input device;

FIGURE 2 is a schematic diagram of a system for supporting use of the electronic pen described in connection with FIGURE 1;

FIGURE 3 is an illustration of the protocol stacks that can be used in the case of local communications between an electronic pen and an electronic pen client;

FIGURE 4 is an illustration of protocol stacks that can be used when an electronic pen and an electronic pen client communicate with one another via an Internet connection;

FIGURE 5 is an illustration of a protocol stack for communications between an electronic pen client and each of the supporting entities when the electronic pen client is not located within a server on the Internet;

FIGURE 6 is an illustration of protocol stacks that are used for communications between an electronic pen

client and each of the supporting entities when the electronic pen client is located on the Internet;

FIGURE 7 is a block diagram of the electronic pen logic that handles positions, strokes, actions, and grid descriptions;

FIGURE 8 is a block diagram of a state machine for the electronic pen control block shown in FIGURE 7;

FIGURE 9 is a block diagram of a state machine for an electronic pen client;

FIGURES 10A-10C are a message flow and signaling diagram illustrating the operation of the electronic pen system shown and discussed in connection with FIGURE 2; and

FIGURE 11 is an illustration of a preferred embodiment of an electronic hand scanner for scanning printed information in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a system in which an electronic reading device, such as an electronic pen, an electronic mouse, or a hand scanner, works in cooperation with an address pattern (e.g., a specially formatted

paper) to provide for a detection of a location of the electronic reading device over the address pattern. For instance, a pattern of dots can be defined such that, by examining a very small portion of the pattern, a precise location in the overall pattern can be determined. In fact, it is possible to define a pattern that has the size of 73,000,000,000,000 A4 pages, which is equivalent to half the size of the entire United States. Portions of the pattern can be placed on sheets of paper or other objects.

Then, using an electronic scanner pen that can detect the dots in the pattern, it is possible to detect the location of the pen with respect to the unique pattern. For example, when such a pen is used in connection with a specially formatted paper, the pen can detect its position (e.g., using a built in camera) by detecting a 3 mm by 3 mm portion of the pattern. By taking approximately 100 pictures per second, the pen is capable of determining its exact position to within 0.1 mm or less. This system can be used to provide user input, to facilitate user interaction, or to store handwritten notes or drawings. Moreover, by associating portions of the overall pattern with certain applications, such a system can be used to interact with wide variety of applications.

Referring now to FIGURE 1, there is illustrated an example of a system 2 in which an electronic pen 10 can be used as an input device. The electronic pen 10 includes an ink cartridge and is capable of writing in a typical fashion. The electronic pen 10, however, includes some type of sensor (e.g., a built-in camera) that is used for detecting an address pattern on a specially formatted piece of paper 12. In particular, the paper 12 is formatted with a small portion of a large address pattern such that when the electronic pen 10 is used to write on or otherwise make marks on the paper 12, the writings or markings can be electronically detected and stored.

As an example, the paper 12 might constitute a form that can be used for sending an email. Thus, the paper 12 might include a space for writing in the email address of an intended recipient, a space for writing a subject of the email, and a space for writing the body of the email. As the electronic pen 10 is used to fill in each of the spaces, the position and movement of the electronic pen 10 on the paper 12 can be determined by repeatedly detecting the current x, y coordinates of the pen 10 (e.g., at rate of 100 frames per second). The markings can then be converted into ASCII text using an appropriate handwriting

recognition program. Once the user completes the form, the email can be sent, for example, by checking a send box at a predetermined location on the paper 12.

Preferably, the coordinate information collected by the pen 10 is sent by a short range radio transmitter in the electronic pen 10 to a nearby mobile station 14 using a short range radio interface 16 such as a local wireless radio link (e.g., a local wireless radio link supported by Ericsson's Bluetooth™ wireless communications technology). Alternatively, instead of using a mobile station 14, the coordinate information could also be sent to, for instance, a desktop or portable computer, a personal digital assistant (PDA), a television, or a Bluetooth terminal. Moreover, instead of using a local wireless radio link, other types of local wireless links, such as inductive coupling and infrared light; other types of radio links, such as Global System for Mobile Communication (GSM); or wired transmission media, such as a cable can also be used. The information can then be forwarded via an appropriate link, such as a cellular air interface 18, to a base station 20 or other network node.

Referring now to FIGURE 2, there is illustrated a schematic diagram of a system 2 for supporting use of the

electronic pen 10 described in connection with FIGURE 1. Throughout the subsequent discussion, the system 2 is described primarily in connection with an electronic pen 10. It will be understood, however, that the invention and the underlying system 2 can instead use any type of electronic reading device, such as an electronic pen, an electronic mouse, or a hand scanner. As shown in FIGURE 2, the system 2 includes six different entities, including the electronic pen 10, electronic pen client 22, a control node 24, a name server 26, a base translator 28, and an application server 30. Although these various devices are described and depicted separately, it is also possible to combine two or more of the entities into the same device (e.g., the electronic pen 10 and electronic pen client 22 can be contained in the same device).

The electronic pen 10 is responsible for detecting positions on the address pattern, producing actions, and sending information to the electronic pen client 22. In addition to being able to leave pen markings, some electronic pens can also have the ability to produce other types of output, such as sound, vibration, or flashing lights. The electronic pen 10 includes a memory for storing a current grid, which comprises information

relating to an area of the address pattern that is near the most recently detected position of the electronic pen 10. When the electronic pen 10 is loaded with the current grid, it knows what actions to take based on the positions that are read from the address pattern. When the electronic pen 10 is first turned on or when it moves to an area outside of the current grid, the electronic pen 10 must first request a new grid description before it can continue processing information. In such a situation, the electronic pen 10 requests a new grid description from the electronic pen client 22.

The electronic pen client 22 can be located in a mobile station 14, in a PDA, in a desktop or portable computer, in the electronic pen 10 itself, in a server somewhere on the Internet, or in another device. The electronic pen client 22 serves as the center of communications in the overall system 2. In particular, the electronic pen client 22 receives new grid requests and action requests from the electronic pen 10 and responds to these requests by contacting an appropriate entity within the overall system 2 to properly respond to the request from the electronic pen 10. Furthermore, when the electronic pen 10 is being used in connection with a

particular application, the electronic pen client 22 can store the application and/or any corresponding data received from the electronic pen 10 to facilitate processing and use of the application.

The name server 26 is used for translating a detected position on the address pattern into a Uniform Resource Location (URL) associated with that position. Different portions of the address pattern are assigned to different applications. Neither the electronic pen 10 nor the electronic pen client 22, however, is aware of all of the different applications and the particular areas assigned to each application. Thus, when the electronic pen 10 detects a new or unknown position, it forwards the position information to the electronic pen client 22, which in turn sends the information to the name server 26. The name server 26 then identifies an application associated with the received position and retrieves a URL where a description of the particular application can be found. The retrieved URL can then be used by the electronic pen client 22 to retrieve the application description.

As an alternative, the name server 26 can comprise a global name server that keeps track of a location, in the

form of URLs to local name servers, where more information can be found about different addresses in the pattern. Similarly, each local name server can use other local name servers to obtain the necessary information, i.e., to convert a position into a URL where an application description can be found. At the lowest level, the local electronic pen client should know all the paper addresses that are within a specific application or applications.

There are some services that should be available in the overall system 2 for which it is inconvenient or not feasible to support such services in the electronic pen 10 or the electronic pen client 22. In such a case, the base translator 28 can be used to support the services. For example, the base translator 28 might contain handwriting recognition software for converting pen actions into text or for converting pen actions into a predefined set of symbols. When such services are needed, the electronic pen client 22 can send a request to the base translator 28 along with the necessary data, and the base translator 28 can perform the requested service.

Another entity in the system 2 is a control node 24. The control node 24 is used for responding to actions in a standardized way. For example, the control node 24 can be

used to respond to certain generic functions, such as "cancel" or "submit" functions, in a consistent manner without regard to the particular application that is currently active.

In addition, the control node 24 is used for creating streaming-like applications. For instance, some applications might require that the positions on the address pattern that are detected by the electronic pen 10 be immediately sent, upon detection, to the electronic pen client 22 for use by the application (i.e., the electronic pen 10 does not wait to transmit the position data until a complete stroke is detected or until a "send" field is touched). One example is an application that is used to control an industrial robot in a warehouse. In such a case, the application description that is loaded onto the electronic pen server 22 can include instructions that all positions be streamed to a control node 24. As a result, the control node 24 can receive the positions in real time and can control the robot without waiting for the form (i.e., the current grid) to be completed. Thus, the control node 24 can perform a real-time translation from detected positions to a responsive action, such as moving

an object (e.g., a robot, a valve, etc.) or controlling a process.

The application server 30 is a regular web or wireless application protocol (WAP) server that supports an application associated with a particular area of the address pattern. The application server 30 stores an application description and provides the application description to the electronic pen client 22 upon request. In addition, the application server 30 receives input data from the electronic pen 10 via the electronic pen client 22. For example, the application description might define a number of data entry areas on a form. Thus when data is entered on the form by the electronic pen 10, the data is received by the electronic pen client 22, converted into text using handwriting recognition software, and forwarded to the application server 30, which stores the data or otherwise processes the data in accordance with the function of the application.

Referring now to FIGURES 3 through 6 there are illustrated various examples of protocol stacks that can be used for communicating between the entities shown in FIGURE 2. Generally, however, such protocols apply however, only if the two communicating entities are

implemented in different devices. If two or more entities are combined into one device, a proprietary protocol can be used to communicate between the entities. FIGURE 3 illustrates the protocol stacks that can be used in the case of local communications (e.g., using Bluetooth) between the electronic pen 10 and the electronic pen client 22. If, on the other hand, the electronic pen 10 and the electronic pen client 22 communicate with one another via an Internet connection, the protocol stacks depicted in FIGURE 4 will be used. FIGURE 5 illustrates a protocol stack for communicating between the electronic pen client and each of the supporting entities, such as the name server 26, the control node 24, the base translator 28, and the application server 30, when the electronic pen client 22 is not contained within a server on the Internet (e.g., such as when the electronic pen client 22 is located in a mobile phone 14). Finally, FIGURE 6 depicts the protocol stacks that are used when the electronic pen client 22 is located on the Internet.

There are a number of procedures that can be used by the various entities in the system 2 to allow the system to operate properly. When the electronic pen 10 detects a position on the address pattern that is not within its

currently loaded grid or when the electronic pen 10 has no currently loaded grid, the electronic pen 10 initiates a new grid procedure. The new grid procedure involves sending a new grid request object to the electronic pen client 22. The new grid request object contains the newly detected position, a description of the actions that the electronic pen 10 can natively support, and a description of the output signals that the electronic pen 10 supports. The reply to a new grid request object is a grid description, which can be provided by the electronic pen client 22 from its own internal memory or from the information provided by an application server 30. Generally, the electronic pen client 22 extracts the grid description from an application description received from the application server 30. The grid description should only contain action-field-types that the electronic pen 10 has indicated that it natively supports, which means that the electronic pen client 22 in some cases should convert the extracted grid description into a format that the electronic pen 10 can understand.

In some situations, it may be necessary for the electronic pen 10 to unload its current grid at the request of the electronic pen client 22. In such a case,

the electronic pen client 22 sends an empty grid description to the electronic pen 10, thereby causing the electronic pen 10 to unload its current grid. This can occur, for example, when a particular application is complete or when a new grid description request received from the electronic pen 10 cannot be fulfilled, such as when the position received from the electronic pen 10 is not registered in the name server 26.

Another similar message is the empty grid description with a grid exception. When the electronic pen 10 requests a new grid description from the electronic pen client 22, the electronic pen client 22 uses the detected position specified in the request to ask the name server 26 for a URL where the application description can be found. If no URL is returned, the electronic pen client 22 can send an empty grid description with a grid exception to the electronic pen 10. The grid exception comprises a rectangle or other shape indicating the area around the detected position where no registered applications can be found. Preferably, the indicated area is as large as possible so that the electronic pen 10 and/or electronic pen client 22 know the extent of the surrounding area that is unassigned and do not have to

repeatedly send requests to the name server 26. Thus, the empty grid description with a grid exception causes the electronic pen 10 to unload its current grid and also informs the electronic pen 10 of an area surrounding the detected position that can essentially be ignored because its is not associated with any application.

The procedure that is used when the electronic pen 10 detects a new position is a find application description location procedure. This procedure is used by the electronic pen client 22 to translate a detected position received from the electronic pen 10 into a URL where a description of an application corresponding to that position can be found. The procedure involves sending a request from the electronic pen client 22 to the name server 26 containing identification of the detected position. The name server 26 responds by sending a reply to the electronic pen client 22 containing a URL where an application description can be found or, if the detected position is not registered in the name server 26, containing an indication that no associated application is known to exist.

Once the electronic pen client 22 knows the URL where an application description can be found, the electronic

pen client 22 can initiate a get application description procedure, which allows the electronic pen client 22 to retrieve the application description from the application server 30. In particular, the electronic pen client 22 sends an application description request containing a unique ID for the requesting electronic pen 10 and/or electronic pen client 22 to the application server 30 located at the URL address provided by the name server 26. In response, the application server 30 provides an application description object to the electronic pen client 22, which loads the application onto the electronic pen client 22. The application description object is similar to an HTML form with some additions and modifications.

Furthermore, the application description object can be sent from the application server 30 to the electronic pen client 22 in response to a submitted form (i.e., a submission of one completed form might automatically result in a new form being loaded onto the electronic pen client 22). A related procedure is the application submit procedure, which is used by the electronic pen client 22 when the user of the electronic pen 10 selects a "submit" field in a form. In response to the selection of the

"submit" field, the electronic pen client 22 will submit the form content in accordance with instructions received in the application description. Typically, the electronic pen client 22 will submit the form content, in the same way as a regular web browser, to a URL specified in a form tag of the application description.

When an action that can be handled by the electronic pen 10 itself is generated, an action procedure is initiated by the electronic pen 10 to send an action request object to the electronic pen client 22. If the electronic pen client 22 cannot translate the action into a field value itself, the electronic pen client 22 further forwards the request to a base translator 28 for translating the action into a field value. In response to the action request object, an action reply object is sent from the electronic pen client 22 to the electronic pen 10. The action reply object contains output information that indicates to the electronic pen 10 which outputs signals to use. The output information, however, cannot be of type that the electronic pen 10 has previously indicated that it does not support. In some instances, the action reply object might contain a new grid description. In such a case the electronic pen 10 will unload its

current grid description and load the new grid description. Similarly, if the action reply object contains an empty grid description, the electronic pen 10 will simply unload its current grid description.

The action request object is also sometimes used to specify actions that should be processed by the control node 24. In this instance, the electronic pen client 22 initiates a control procedure by forwarding the received action to the appropriate control node 24. As a result, the control node 24 sends an action reply object to the electronic pen client 22.

The operation of the electronic pen 10 will now be discussed in greater detail. Each electronic pen 10 has a unique pen ID, which is sent to the application server 30 when an application description is requested. The electronic pen ID allows the application to identify the particular user that is using the application and to distinguish between multiple concurrent users of the same application, such as when different electronic pens 10 are being used in connection with separate sheets of paper that each contain the same portion of the address pattern.

Referring now to FIGURE 7, there is illustrated a block diagram of the electronic pen logic that handles

positions, strokes, actions, and grid descriptions for the electronic pen 10. The electronic pen 10 includes a control block 32 for controlling the operation of the electronic pen 10. A grid description block 34 represents a memory location that stores a current grid description. At any given time, the electronic pen 10 can be in either of two modes. In a first mode, a grid description is loaded, while in a second mode, the grid description block 34 is not loaded with a current grid description.

As the electronic pen 10 moves across an address pattern, the electronic pen 10 periodically (e.g., every 1/100 of a second) detects a position by detecting all of the dots within, for example, a 3mm by 3mm area. Each detected position is forwarded (as indicated at 36) to a position first in first out (FIFO) block 38, which acts as a buffer for temporarily storing the detected positions. The clocking of the position FIFO block 38 is controlled by the control block 32 (as indicated at 40).

The detected position is fed from the position FIFO block 38 (as indicated at 42) to an in grid detector 44. The in grid detector 44 retrieves data from the grid description block 34 (as indicated at 46) and determines whether the received position is within the loaded grid

description. If not, the in grid detector 44 notifies the control block 32, which in turn initiates a request for a new grid. When the detected position is within the current grid, the position is then sent (as indicated at 50) from the in grid detector 44 to a stroke engine 52. The stroke engine 52 converts the received positions into strokes, which are then sent (as indicated at 54) to an action engine 56. A complete stroke is created when the electronic pen 10 is lifted from the paper or when it moves outside of the grid field where the stroke began. Finally, the action engine 56 converts the received stroke into an action that can be sent to the electronic pen client 22. By using grid action-field-types, the action engine knows which type of action to produce for a specific grid field.

Referring now to FIGURE 8, there is illustrated a block diagram of a state machine for the control block 32 shown in FIGURE 7. In this figure, events are indicated in capital letters, while tasks associated with the event are depicted in brackets. The process starts at step 60 with a start up event 62, which causes the position FIFO block 38 to begin receiving detected positions. Initially, the electronic pen 10 is in a no grid loaded

state 64, which means that the electronic pen 10 does not have a grid loaded in the grid description block 34. As a result, the control block 32 generates an outside grid indication 66, thereby causing the electronic pen 10 to send the request for a new grid description to the electronic pen client 22 (i.e., in accordance with the new grid procedure) and to stop the FIFO buffer 38. At this point, the electronic pen 10 enters a waiting for grid state 68.

Once the new grid has been received (as indicated at 70), the control block 32 moves to a grid loaded state 72, at which time the new grid is loaded into the grid description block 34 and the position FIFO block 38 resumes operation. On the other hand, if no grid is received (as indicated at 74), at least a portion of the positions stored in the FIFO buffer 38 are erased. Which part of the FIFO buffer to erase is determined by the grid exception area, if any, in the received empty grid description. Accordingly, all positions stored in the FIFO buffer 38 that are within the grid exception area should be erased. If no grid exception is received, the stroke associated with the position is erased. In

addition, the FIFO block 38 resumes operation and the control block 32 moves into the no grid loaded state 64.

When the control block 32 is in the grid loaded state 72, a current grid is loaded in the grid description block 34. While the control block 32 remains in this state 72, the position FIFO block 38 continues to receive detected positions and passes them on to the stroke engine 52 and action engine 56. Actions produced by the action engine 56 are sent (as indicated at 58) to the electronic pen client 22 (i.e., in accordance with the action procedure described above).

At some point, an outside grid indication 74 may be received by the control block 32 from the in grid detector 44. The outside grid event 74 causes the FIFO block 38 to stop generating new positions. In addition, the electronic pen 10 enters a flushing stroke and action state 76 wherein the strokes that are currently in the stroke engine 52 and the actions that are currently in the action engine 56 are flushed to the electronic pen client 22. Once the stroke engine 52 and action engine 56 have been fully flushed (as indicated at 78), the electronic pen 10 sends a request for a new grid to the electronic pen client 22 and unloads the current grid. The control

block 32 then moves back into the waiting for grid state 68.

As a general matter, the electronic pen 10 may be capable of supporting various different types of output, including audio, such as warning tones; visual, such as a flashing light; tactile, such as vibration; and/or ink. In some cases, it might be desirable to allow the user of the electronic pen 10 to turn off the ink of the pen 10, such as when the electronic pen is being used on a portion of the address pattern that is public or shared or when the user wants to be able to reuse the current sheet of paper.

The electronic pen client 22 will now be described in greater detail. Generally, the electronic pen client 22 is analogous to a regular web browser. It is responsible for loading applications from application servers 30 and for handling input form the electronic pen 10. Preferably, the electronic pen client 22 is located in a separate device from the electronic pen 10 itself. This is because it is desirable to minimize the size and power supply requirements of the electronic pen 10, which will likely be adversely affected by the processing resources and memory necessary to support the functions of the electronic pen client 22.

Referring now to FIGURE 9, there is illustrated a block diagram of a state machine for the electronic pen client 22. Initially, the electronic pen client 22 is in a no application loaded state 80. The electronic pen client 22 recognizes only one signal when in this state 80, namely a new grid request from the electronic pen 10. Such a request causes a load grid indication event 82. The electronic pen client 22 responds by sending a request to the name server 26 to translate a position contained within the new grid request into a URL where the application description can be found (i.e., in accordance with the find application location procedure). Next, the electronic pen client 22 enters a waiting for application description URL state 84. If no URL for the application description can be found (as indicated at 86), the electronic pen client 22 sends a new grid reply to the electronic pen 10, wherein the reply contains an empty grid description with a grid exception. As a result, the electronic pen client 22 returns to the no application loaded state 80.

If a URL for the application description is received from the name server 26 (as indicated at 88), the electronic pen client 22 sends a request to the

application server 30 to retrieve the application description (i.e., in accordance with the get application description procedure). Accordingly, the electronic pen client 22 enters a waiting for application description state 90.

If the electronic pen client 22 does not receive an application description from the application server 30 (as indicated at 92), a new grid reply is sent by the electronic pen client 22 to the electronic pen 10 wherein the reply contains an empty grid. Thus, the electronic pen client 22 returns to the no application loaded state 80. If, however, the electronic pen client 22 does receive an application description from the application server 30 (as indicated at 94), the electronic pen client 22 sends a new grid reply to the electronic pen 10 containing a new grid description, and the electronic pen client 22 loads the application in its memory. In addition, the electronic pen client 22 moves into an application loaded state 96.

In the application loaded state 96, five types of actions can be received by the electronic pen client 22 from the electronic pen 10. First, a received action can include a request that the electronic pen client 22 cannot

handle itself, in which case the electronic pen client 22 will send the action to the base translator 28 (as indicated at 98). The electronic pen client 22 then moves into a waiting for response from the base translator state 100. Once a base translator response 102 is received by the electronic pen client 22, the electronic pen client 22 updates a current form or other data associated with the currently loaded application and sends an action reply to the electronic pen 10 with appropriate output information.

Another type of action that the electronic pen client 22 can receive from the electronic pen 10 is a request that should be forwarded to a control node 24. In such a case, the action is sent to a control URL specified in the application description (as indicated at 104), and the electronic pen client 22 enters a waiting for response from the control state 106. Once a response is received from the control (as indicated at 108), the electronic pen client 22 sends an action reply to the electronic pen 10 with appropriate output information.

A third type of action is a submit form request, in response to which the electronic pen client 22 will submit the current form to the application server 30 that is identified by the URL in the application description (as

indicated at 110). The electronic pen client 22 then enters a waiting for response from the application server state 112. If the application server 30 responds by sending an empty application description to the electronic pen client 22 (as indicated at 114), the current application is unloaded from the electronic pen client 22 and an action reply is sent to the electronic pen 10 with an empty grid. As a result, the electronic pen client 22 returns to the no application loaded state 80. On the other hand, if the application server 30 responds with a non-empty application description, the old application is unloaded from the electronic pen client 22, the new application description is parsed and loaded in the electronic pen client 22, an action reply is sent to the electronic pen 10 with a new grid description and with appropriate output information, and finally the electronic pen client 22 returns to the application loaded state 96.

A fourth type of action that can be received by the electronic pen client 22 from the electronic pen 10 is a request to load a new grid. This action occurs, for example, when a position outside of the current grid is detected by the electronic pen 10. When a new grid request is received, the electronic pen client 22 sends a

request to the name server 26 (as indicated at 116) and the electronic pen client 22 returns to the waiting for application description URL state 84.

Finally, a fifth type of action that can be received by the electronic pen client 22 is an action that the electronic pen client 22 can handle itself, in which case the electronic pen client 22 updates the current form and sends an action reply to the electronic pen 10 with appropriate output information (as indicated at 118). The electronic pen client 22 then remains in the application loaded state 96. One type of action that the electronic pen client 22 might be able to handle itself is a local application. For example, the electronic pen client 22 might be capable of performing certain basic functions that are defined by a local application. Thus, when the electronic pen client 22 receives a new grid request, the position associated with the new grid request can be analyzed to determine if it corresponds to a local application. If so, the electronic pen client 22 can load the application description from its local memory, send a new grid description to the electronic pen 10 without having to communicate with the name server 26 or the application server 30.

Another action that might be handled locally by the electronic pen client 22 relates to the selection of fields within a form. When the electronic pen client 22 receives an action, the field that corresponds to that action receives focus. When this occurs, the electronic pen client 22 might display the field's value on its display or output the value by audio. In addition, the electronic pen client 22 might allow the user to edit the value of the field by means other than the electronic pen 10. Yet another type of action that might be handled by the electronic pen client 22 itself are actions that relate to a clipboard function. When a "copy" field is selected, the value of the field that had focus at the time the copy field was selected is transferred to the clipboard. Similarly, when a "paste" field is selected, the value stored in the clipboard is transferred to the field that had focus at the time the paste field was selected.

Referring now to FIGURES 10A through 10C, there is shown, by way of example, a message flow and signaling diagram illustrating the operation of the electronic pen system 2 depicted in and discussed in connection with FIGURE 2. Initially, the electronic pen 10 detects a

first position on the address pattern at step 120 (e.g., at a location on a sheet of paper designated for composing and sending emails). At this stage, it is assumed that the electronic pen 10 is in a no grid loaded state. Thus, in response to the detection of the first position, the electronic pen 10 sends a new grid request 122, which contains the detected position information, to the electronic pen client 22. As a result, the electronic pen client 22 sends an application location request 124 containing the detected position information to the name server 26, at step 126. The name server 26 translates the detected position into a URL where an application description that corresponds to the detected position can be found (e.g., a URL address for a server containing an email application), and returns an application location reply 128 containing the retrieved URL to the electronic pen client 22.

The electronic pen client 22 then sends an application description request 130, which contains the unique pen ID for the electronic pen 10, to the application server 30. The application server 30 retrieves the application description at step 132 and sends an application description reply 134 containing the

retrieved application description to the electronic pen client 22. The electronic pen client 22 then parses and stores the application description at step 136. This step further involves generating a current grid description from the application description and sending the grid description to the electronic pen 10 in a new grid reply 138. The electronic pen 10 stores the received grid description at step 140 and resumes processing of the detected positions. Using the detected positions and the information in the grid description (e.g., so that the electronic pen 10 knows which fields of the email form are being filled in), the electronic pen 10 generates strokes at step 142 and generates actions at step 144 using the stroke engine 52 and action engine 56 shown in FIGURE 7.

Each time an action is generated that cannot be handled by the electronic pen 10 itself, an action request 146 containing a description of the action is sent from the electronic pen 10 to the electronic pen client 22. At this point, the electronic pen client 22 should determine what type of action has been received so that it can respond to the action in an appropriate manner. First, it is determined whether the action requires the attention of, or otherwise should be processed in accordance with, a

local application at step 148. Very basic applications or frequently used applications (e.g., delete entered text), for example, might be stored locally to avoid having to contact another entity. In such a case, the electronic pen client 22 retrieves the local application at step 150 and sends an action reply 152, which can contain a new grid description or other appropriate information.

However, if it is determined at step 148 that the received action does not relate to a local application, the process continues at step 154 where it is determined whether the received action requires processing by an external translator (e.g., handwriting recognition). If so, an action request 156 containing a description of the action is sent by the electronic pen client 22 to the base translator 28. The base translator 28 processes the action at step 158 and sends an action reply 160 containing output information responsive to the received action (e.g., text corresponding to written characters) to the electronic pen client 22, which can forward the output information to the electronic pen 10 in an action reply 162, if necessary.

If it is determined at step 154 that the received action does not require processing by an external

translator, it is next determined whether the action relates to a control application at step 164. If so, an action request 166 containing a description of the action is sent by the electronic pen client 22 to the control server 24. The control server 24 processes the received action at step 168 and, if a response is necessary, returns output information responsive to the received action in an action reply 170, which is forwarded from the electronic pen client 22 to the electronic pen 10 in an action reply 172.

Assuming that it is determined at step 164 that the received action does not relate to a control function, it is next determined whether the action comprises a request to submit a form at step 174 (e.g., a selection of a "send" area on the email form). If so, an action request 176 containing the data entered onto the form is sent by the electronic pen client 22 to the application server 30. The application server 30 processes the form at step 178 and sends an action reply 180 containing a new application description (or an empty application description) to the electronic pen client 22. The electronic pen client 22 parses and stores the new application description at step 182 and generates a new grid description from the newly

received application description. The electronic pen client 22 then sends an action reply 184 containing the new grid description. Although not illustrated in the figure, the electronic pen 10 will typically respond to the receipt of a new grid description by unloading its current grid description and loading the new grid description into its memory.

At some point, it is assumed that the electronic pen 10 detects a position that is outside of the currently loaded grid at step 186. In response to such an event, the electronic pen 10 sends a new grid request 188 containing the newly detected position data to the electronic pen client 22. In response, the electronic pen client 22 again generates an application location request 190 containing the detected position data and sends the request to the name server 26. The name server 26 determines whether a URL for an application description that corresponds to the newly detected position is available at step 192.

If so, the name server 26 sends an application location reply 194 containing a retrieved URL to the electronic pen client 22, which in turn sends an application description request 196 containing the unique

pen ID for the electronic pen 10 to the application server 30 at the identified URL address, just as previously discussed in connection with messages 128 and 130. In this case, however, it is assumed that the application server 30 determines that the requested application description is unavailable at step 198. As a result, the application server 30 sends an application description reply to the electronic pen client 22 containing an empty application description. In response to the receipt of an empty application description, the electronic pen client 22 unloads the current application at step 202 and sends a new grid reply 204 containing an empty grid description to the electronic pen 10. The electronic pen 10 responds to the receipt of the empty grid description by unloading the current grid description at step 206.

Another possibility is that the name server 26 determines at step 192 that a URL corresponding to the detected position is not available. In this situation, the name server 26 sends an application location reply 208 to the electronic pen client 22. The reply 208 may simply be empty to indicate that a URL is not available. Preferably, however, the reply 208 contains a grid exception defining the largest area possible around the

detected position for which there is no corresponding URL. In response to the reply 208, the electronic pen client 22 sends a new grid reply 210 containing an empty grid description with a grid exception. Upon receiving the reply 210, the electronic pen 10 unloads the current grid description at step 212. Furthermore, assuming that the electronic pen 10 receives and recognizes the grid exception information, the electronic pen 10 may subsequently be able to determine that certain detected positions on the address pattern are not associated with any application without having to send a request to the name server 26 or the application server 30.

In addition to being able to detect movements of the electronic pen 10 (e.g., for purposes of inputting handwritten text or drawings), it may also be desirable in some cases to use the electronic pen 10 or a similar device, such as an electronic hand scanner, to scan information previously printed on a specially formatted surface. Such scanned information could be stored in the electronic pen 10 and/or transmitted to the electronic pen client 22 for storage or for processing in accordance, for example, with an application description retrieved from the application server 30.

To facilitate scanning, information to be scanned should be printed or drawn on a surface that includes a preprinted address pattern. The information can include, for example, a painting, typed characters, handwritten or printed drawings or images, and/or handwritten text on the addressed paper sheet. To enable the address pattern to be distinguished from the printed information, the address pattern is of a different type of color than is used for the printed information. Preferably, the printed information uses colors that are within the visible light spectrum, while the address pattern uses a different portion of the visible light spectrum or is printed within either the ultraviolet spectrum or infrared spectrum. An electronic hand scanner can then simultaneously read the printed information and the underlying address pattern by detecting reflected light in two different spectra.

Referring now to FIGURE 11, there is illustrated a preferred embodiment of an electronic hand scanner 220 for scanning printed information in accordance with the present invention. The electronic hand scanner 220 is capable of simultaneously detecting two layers 222 and 224 of a specially formatted surface 226. The formatted surface can include, for example, a sheet of paper, or a

display screen for displaying images or other information, wherein the address pattern is preprinted on the display screen or is generated on the display screen as background to a displayed image. The first layer 222 of the formatted surface 226 includes the printed information and the second layer 224 includes the preprinted address pattern 228.

The printed information is shown as text in this example for ease of illustration. However, as mentioned above, the printed information can be of any type and on virtually any type of surface. Although the two layers 222 and 224 are shown separately, it will be understood that the information printed on each layer 222 and 224 can be included on the same surface 226. In addition, although the printed information layer 222 is depicted as overlying the address pattern layer 224, it will be understood that the printed information can be printed on a surface that is pre-formatted with the address pattern 228 or that the address pattern can be superimposed over preexisting printed information. The electronic hand scanner 220 includes a light emitting element 230 for illuminating the formatted surface 226 and a reading sensor 232 for detecting both the printed information

layer 222 (as indicated at 236) and the address pattern layer 224 (as indicated at 234).

In one embodiment of the invention, the light emitting element 230 illuminates the surface 226 with a broad spectrum light. The reading sensor 232 includes a plurality of sensing pixels wherein a filter is placed over every other sensing pixel. In this embodiment, it is assumed that the printed information layer 222 is printed using an ink that will reflect only a portion of the light spectrum (e.g., visible light or a portion thereof). The address pattern layer 224, on the other hand, is printed using an ink that reflects a second portion of the light spectrum, which differs from the first portion of the light spectrum used for the printed information layer 222. The filter that is placed over every other sensing pixel then filters light reflected by the printed information layer 222 and enables sensing of the address pattern 228. Thus, sensing pixels with a filter generate address layer images, while pixels without a filter generate printed information layer images. As a result, the printed information does not interfere with the detection of the address pattern 228 (and vice versa).

Each pixel of printed information can be associated with a particular portion of the address pattern 228 so that a precise location of each pixel of printed information can be determined. For example, by forwarding the detected printed information and the corresponding portion of the address pattern to a processor 238 in the electronic hand scanner 220 or in another device, the processor 238 can map information detected from the printed information layer 222 onto the address pattern 228. More particularly, the processor 238 uses software to map the detected printed information onto an electronically stored copy of the address pattern 228 using the detected portions of the address pattern that are associated with the detected printed information. In a second embodiment of the invention, the light emitting element 230 includes two types of light emitting diodes (LEDs). The first type of LED emits infrared light, while the second type of LED emits non-infrared light, preferably visible light. The LEDs are then switched on and off at half the sensor rate or, alternatively, the sensor rate is doubled and the two types of LEDs are turned on in alternating sensing intervals. Images sensed by the reading sensor 232 under infrared light then

contain the address layer, while images sensed by the reading sensor 232 under visible light show the printed information layer 222.

In either of these embodiments, when the electronic hand scanner 220 is moved across the surface 226, the processor 238 can reconstruct the printed information precisely. Because each pixel of printed information can be associated with a unique portion of the address pattern 228, the scanned information can be reconstructed precisely regardless of how many times or in which direction the electronic hand scanner 220 is moved or rubbed across the surface. If only parts of the image are scanned, the exact distance between the scanned areas can be determined. Special applications can be created for use in generating an electronic copy of a picture, text, musical notes, or any other printed information, and the processor 238 can output the scanned information in the form of sound, text, or images.

Although various preferred embodiments of the method and apparatus of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it is understood that the invention is not limited to the embodiments disclosed,

but is capable of numerous rearrangements, modifications, and substitutions without departing from the spirit of the invention as set forth and defined by the following claims. Furthermore, it shall be understood that the terms "comprises" and "comprising," when used in the foregoing Detailed Description and the following claims, specifies the presence of stated features, elements, steps, or components but does not preclude the presence or addition of one or more other features, elements, steps, components, or groups thereof.